Appendix A

ADDLW **ADD literal to W**

Syntax: [*label*] ADDLW k

Operands: $0 \le k \le 255$

Operation: $(W) + k \rightarrow W$

Status Affected: N,OV, C, DC, Z

Encoding:

0000	1111	kkkk	kkkk

Description: The contents of W are added to the 8-bit literal 'k' and the result is placed in W.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process Data	Write to W

Example: `ADDLW 0x15`

Before Instruction

W = 0x10

After Instruction

W = 0x25

ADDWF **ADD W to f**

Syntax: [*label*] ADDWF f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: $(W) + (f) \rightarrow dest$

Status Affected: N,OV, C, DC, Z

Encoding:

0010	01da	ffff	ffff

Description: Add W to register 'f'. If 'd' is 0 the result is stored in W. If 'd' is 1 the result is stored back in register 'f' (default). If 'a' is 0 Virtual bank will be selected. If 'a' is 1 the BSR will not be overridden (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example: `ADDWF REG, 0, 0`

Before Instruction

W = 0x17
REG = 0xC2

After Instruction

W = 0xD9
REG = 0xC2

ADDWFC — ADD W and Carry bit to f

Syntax: [*label*] ADDWFC f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: (W) + (f) + (C) → dest

Status Affected: N,OV, C, DC, Z

Encoding:

0010	00da	ffff	ffff

Description: Add W, the Carry Flag and data memory location 'f'. If 'd' is 0, the result is placed in W. If 'd' is 1, the result is placed in data memory location 'f'. If 'a' is 0 Virtual bank will be selected. If 'a' is 1 the BSR will not be overridden.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example: `ADDWFC REG, 0, 1`

Before Instruction
Carry bit = 1
REG = 0x02
W = 0x4D

After Instruction
Carry bit = 0
REG = 0x02
W = 0x50

ANDLW — AND literal with W

Syntax: [*label*] ANDLW k

Operands: $0 \le k \le 255$

Operation: (W) .AND. k → W

Status Affected: N,Z

Encoding:

0000	1011	kkkk	kkkk

Description: The contents of W are AND'ed with the 8-bit literal 'k'. The result is placed in W.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process Data	Write to W

Example: `ANDLW 0x5F`

Before Instruction
W = 0xA3

After Instruction
W = 0x03

ANDWF **AND W with f**

Syntax: [*label*] ANDWF f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: (W) .AND. (f) → dest

Status Affected: N,Z

Encoding:

0001	01da	ffff	ffff

Description: The contents of W are AND'ed with register 'f'. If 'd' is 0 the result is stored in W. If 'd' is 1 the result is stored back in register 'f' (default). If 'a' is 0 Virtual bank will be selected. If 'a' is 1 the BSR will not be overridden (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example: `ANDWF REG, 0, 0`

Before Instruction
W = 0x17
REG = 0xC2

After Instruction
W = 0x02
REG = 0xC2

BC **Branch if Carry**

Syntax: [*label*] BC n

Operands: $-128 \le n \le 127$

Operation: if carry bit is '1'
(PC) + 2 + 2n → PC

Status Affected: None

Encoding:

1110	0010	nnnn	nnnn

Description: If the Carry bit is '1', then the program will branch.
The 2's complement number '2n' is added to the PC. Since the PC will have incremented to fetch the next instruction, the new address will be PC+2+2n. This instruction is then a two-cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:

If Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	Write to PC
No operation	No operation	No operation	No operation

If No Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	No operation

Example: `HERE BC 5`

Before Instruction
PC = address (HERE)

After Instruction
If Carry = 1;
PC = address (HERE+12)
If Carry = 0;
PC = address (HERE+2)

BCF **Bit Clear f**

Syntax: [*label*] BCF f,b,a

Operands: $0 \le f \le 255$
$0 \le b \le 7$
$a \in [0,1]$

Operation: $0 \rightarrow f<b>$

Status Affected: None

Encoding:

1001	bbba	ffff	ffff

Description: Bit 'b' in register 'f' is cleared. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write register 'f'

Example: `BCF FLAG_REG, 7, 0`

Before Instruction
FLAG_REG = 0xC7

After Instruction
FLAG_REG = 0x47

BN **Branch if Negative**

Syntax: [*label*] BN n

Operands: $-128 \le n \le 127$

Operation: if negative bit is '1'
(PC) + 2 + 2n → PC

Status Affected: None

Encoding:

1110	0110	nnnn	nnnn

Description: If the Negative bit is '1', then the program will branch.
The 2's complement number '2n' is added to the PC. Since the PC will have incremented to fetch the next instruction, the new address will be PC+2+2n. This instruction is then a two-cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:

If Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	Write to PC
No operation	No operation	No operation	No operation

If No Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	No operation

Example: `HERE BN Jump`

Before Instruction
PC = address (HERE)

After Instruction
If Negative = 1;
PC = address (Jump)
If Negative = 0;
PC = address (HERE+2)

BNC Branch if Not Carry

Syntax: [*label*] BNC n

Operands: -128 ≤ n ≤ 127

Operation: if carry bit is '0'
(PC) + 2 + 2n → PC

Status Affected: None

Encoding:

1110	0011	nnnn	nnnn

Description: If the Carry bit is '0', then the program will branch.
The 2's complement number '2n' is added to the PC. Since the PC will have incremented to fetch the next instruction, the new address will be PC+2+2n. This instruction is then a two-cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:

If Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	Write to PC
No operation	No operation	No operation	No operation

If No Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	No operation

Example: `HERE BNC Jump`

Before Instruction
PC = address (HERE)
After Instruction
If Carry = 0;
PC = address (Jump)
If Carry = 1;
PC = address (HERE+2)

BNN Branch if Not Negative

Syntax: [*label*] BNN n

Operands: -128 ≤ n ≤ 127

Operation: if negative bit is '0'
(PC) + 2 + 2n → PC

Status Affected: None

Encoding:

1110	0111	nnnn	nnnn

Description: If the Negative bit is '0', then the program will branch.
The 2's complement number '2n' is added to the PC. Since the PC will have incremented to fetch the next instruction, the new address will be PC+2+2n. This instruction is then a two-cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:

If Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	Write to PC
No operation	No operation	No operation	No operation

If No Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	No operation

Example: `HERE BNN Jump`

Before Instruction
PC = address (HERE)
After Instruction
If Negative = 0;
PC = address (Jump)
If Negative = 1;
PC = address (HERE+2)

BNV — Branch if Not Overflow

Syntax: [*label*] BNV n

Operands: -128 ≤ n ≤ 127

Operation: if overflow bit is '0'
(PC) + 2 + 2n → PC

Status Affected: None

Encoding:

1110	0101	nnnn	nnnn

Description: If the Overflow bit is '0', then the program will branch.
The 2's complement number '2n' is added to the PC. Since the PC will have incremented to fetch the next instruction, the new address will be PC+2+2n. This instruction is then a two-cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:

If Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	Write to PC
No operation	No operation	No operation	No operation

If No Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	No operation

Example:

```
HERE    BNV Jump

Before Instruction
  PC              = address (HERE)
After Instruction
  If Overflow     = 0;
    PC            = address (Jump)
  If Overflow     = 1;
    PC            = address (HERE+2)
```

BNZ — Branch if Not Zero

Syntax: [*label*] BNZ n

Operands: -128 ≤ n ≤ 127

Operation: if zero bit is '0'
(PC) + 2 + 2n → PC

Status Affected: None

Encoding:

1110	0001	nnnn	nnnn

Description: If the Zero bit is '0', then the program will branch.
The 2's complement number '2n' is added to the PC. Since the PC will have incremented to fetch the next instruction, the new address will be PC+2+2n. This instruction is then a two-cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:

If Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	Write to PC
No operation	No operation	No operation	No operation

If No Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	No operation

Example:

```
HERE    BNZ Jump

Before Instruction
  PC              = address (HERE)
After Instruction
  If Zero         = 0;
    PC            = address (Jump)
  If Zero         = 1;
    PC            = address (HERE+2)
```

BRA — Unconditional Branch

Syntax: [*label*] BRA n

Operands: -1024 ≤ n ≤ 1023

Operation: (PC) + 2 + 2n → PC

Status Affected: None

Encoding:

1101	0nnn	nnnn	nnnn

Description: Add the 2's complement number '2n' to the PC. Since the PC will have incremented to fetch the next instruction, the new address will be PC+2+2n. This instruction is a two-cycle instruction.

Words: 1

Cycles: 2

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	Write to PC
No operation	No operation	No operation	No operation

Example: `HERE BRA Jump`

Before Instruction
PC = address (HERE)

After Instruction
PC = address (Jump)

BSF — Bit Set f

Syntax: [*label*] BSF f,b,a

Operands: 0 ≤ f ≤ 255
0 ≤ b ≤ 7
a ∈ [0,1]

Operation: 1 → f<b>

Status Affected: None

Encoding:

1000	bbba	ffff	ffff

Description: Bit 'b' in register 'f' is set. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write register 'f'

Example: `BSF FLAG_REG, 7, 1`

Before Instruction
FLAG_REG= 0x0A

After Instruction
FLAG_REG= 0x8A

BTFSC Bit Test File, Skip if Clear

Syntax: [*label*] BTFSC f,b,a

Operands: $0 \le f \le 255$
$0 \le b \le 7$
$a \in [0,1]$

Operation: skip if (f<b>) = 0

Status Affected: None

Encoding:

1011	bbba	ffff	ffff

Description: If bit 'b' in register 'f' is 0 then the next instruction is skipped.
If bit 'b' is 0 then the next instruction fetched during the current instruction execution is discarded, and a NOP is executed instead, making this a two-cycle instruction. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1(2)
Note: 3 cycles if skip and followed by a 2-word instruction

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	No operation

If skip:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

If skip and followed by 2-word instruction:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation
No operation	No operation	No operation	No operation

Example:
```
HERE    BTFSC   FLAG, 1, 0
FALSE   :
TRUE    :
```

Before Instruction
PC = address (HERE)
After Instruction
If FLAG<1> = 0;
PC = address (TRUE)
If FLAG<1> = 1;
PC = address (FALSE)

BTFSS Bit Test File, Skip if Set

Syntax: [*label*] BTFSS f,b,a

Operands: $0 \le f \le 255$
$0 \le b < 7$
$a \in [0,1]$

Operation: skip if (f<b>) = 1

Status Affected: None

Encoding:

1010	bbba	ffff	ffff

Description: If bit 'b' in register 'f' is 1 then the next instruction is skipped.
If bit 'b' is 1, then the next instruction fetched during the current instruction execution, is discarded and an NOP is executed instead, making this a two-cycle instruction. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1(2)
Note: 3 cycles if skip and followed by a 2-word instruction

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	No operation

If skip:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

If skip and followed by 2-word instruction:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation
No operation	No operation	No operation	No operation

Example:
```
HERE    BTFSS   FLAG, 1, 0
FALSE   :
TRUE    :
```

Before Instruction
PC = address (HERE)
After Instruction
If FLAG<1> = 0;
PC = address (FALSE)
If FLAG<1> = 1;
PC = address (TRUE)

BTG Bit Toggle f

Syntax: [*label*] BTG f,b,a

Operands: $0 \le f \le 255$
$0 \le b < 7$
$a \in [0,1]$

Operation: $(\overline{f<b>}) \rightarrow f<b>$

Status Affected: None

Encoding:

0111	bbba	ffff	ffff

Description: Bit 'b' in data memory location 'f' is inverted. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write register 'f'

Example: `BTG PORTC, 4, 0`

Before Instruction:
PORTC = 0111 0101 [0x75]

After Instruction:
PORTC = 0110 0101 [0x65]

BV Branch if Overflow

Syntax: [*label*] BV n

Operands: $-128 \le n \le 127$

Operation: if overflow bit is '1'
(PC) + 2 + 2n → PC

Status Affected: None

Encoding:

1110	0100	nnnn	nnnn

Description: If the Overflow bit is '1', then the program will branch.
The 2's complement number '2n' is added to the PC. Since the PC will have incremented to fetch the next instruction, the new address will be PC+2+2n. This instruction is then a two-cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:

If Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	Write to PC
No operation	No operation	No operation	No operation

If No Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	No operation

Example:
```
HERE    BV   Jump
```

Before Instruction
PC = address (HERE)

After Instruction
If Overflow = 1;
PC = address (Jump)
If Overflow = 0;
PC = address (HERE+2)

BZ — Branch if Zero

Syntax: [*label*] BZ n

Operands: -128 ≤ n ≤ 127

Operation: if Zero bit is '1'
(PC) + 2 + 2n → PC

Status Affected: None

Encoding:

1110	0000	nnnn	nnnn

Description: If the Zero bit is '1', then the program will branch.
The 2's complement number '2n' is added to the PC. Since the PC will have incremented to fetch the next instruction, the new address will be PC+2+2n. This instruction is then a two-cycle instruction.

Words: 1

Cycles: 1(2)

Q Cycle Activity:

If Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	Write to PC
No operation	No operation	No operation	No operation

If No Jump:

Q1	Q2	Q3	Q4
Decode	Read literal 'n'	Process Data	No operation

Example:

```
HERE    BZ   Jump
```

Before Instruction
PC = address (HERE)
After Instruction
If Zero = 1;
PC = address (Jump)
If Zero = 0;
PC = address (HERE+2)

CALL — Subroutine Call

Syntax: [*label*] CALL k,s

Operands: 0 ≤ k ≤ 1048575
s ∈ [0,1]

Operation: (PC) + 4 → TOS,
k → PC<20:1>,
if s = 1
(W) → WS,
(STATUS) → STATUSS,
(BSR) → BSRS

Status Affected: None

Encoding:

1st word (k<7:0>)	1110	110s	$k_7$kkk	kkkk$_0$
2nd word(k<19:8>)	1111	k_{19}kkk	kkkk	kkkk$_8$

Description: Subroutine call of entire 2M byte memory range. First, return address (PC+ 4) is pushed onto the return stack. If 's' = 1, the W, STATUS and BSR registers are also pushed into their respective shadow registers, WS, STATUSS and BSRS. If 's' = 0, no update occurs (default). Then the 20-bit value 'k' is loaded into PC<20:1>. CALL is a two-cycle instruction.

Words: 2

Cycles: 2

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'<7:0>,	Push PC to stack	Read literal 'k'<19:8>, Write to PC
No operation	No operation	No operation	No operation

Example:

```
HERE    CALL   THERE,Fast
```

Before Instruction
PC = Address (HERE)
After Instruction
PC = Address (THERE)
TOS = Address (HERE + 4)
WS = W
BSRS = BSR
STATUSS = STATUS

CLRF — Clear f

Syntax: [*label*] CLRF f,a

Operands: $0 \le f \le 255$
$a \in [0,1]$

Operation: 000h → f
1 → Z

Status Affected: Z

Encoding:

0110	101a	ffff	ffff

Description: Clears the contents of the specified register. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write register 'f'

Example:

```
CLRF    FLAG_REG,1
```

Before Instruction
FLAG_REG = 0x5A
After Instruction
FLAG_REG = 0x00

CLRWDT — Clear Watchdog Timer

Syntax: [*label*] CLRWDT

Operands: None

Operation: 000h → WDT,
000h → WDT postscaler,
1 → $\overline{TO}$,
1 → $\overline{PD}$

Status Affected: $\overline{TO}$, $\overline{PD}$

Encoding:

0000	0000	0000	0100

Description: CLRWDT instruction resets the Watchdog Timer. It also resets the postscaler of the WDT. Status bits $\overline{TO}$ and $\overline{PD}$ are set.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	Process Data	No operation

Example:

```
CLRWDT
```

Before Instruction
WDT counter = ?
After Instruction
WDT counter = 0x00
WDT Postscaler = 0
$\overline{TO}$ = 1
$\overline{PD}$ = 1

COMF — Complement f

Syntax: [*label*] COMF f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: $(\bar{f}) \rightarrow$ dest

Status Affected: N,Z

Encoding:

0001	11da	ffff	ffff

Description: The contents of register 'f' are complemented. If 'd' is 0 the result is stored in W. If 'd' is 1 the result is stored back in register 'f' (default). If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example: `COMF REG, 0, 0`

Before Instruction
REG = 0x13
After Instruction
REG = 0x13
W = 0xEC

CPFSEQ — Compare f with W, skip if f = W

Syntax: [*label*] CPFSEQ f,a

Operands: $0 \le f \le 255$
$a \in [0,1]$

Operation: (f) – (W),
skip if (f) = (W)
(unsigned comparison)

Status Affected: None

Encoding:

0110	001a	ffff	ffff

Description: Compares the contents of data memory location 'f' to the contents of W by performing an unsigned subtraction.
If 'f' = W then the fetched instruction is discarded and an NOP is executed instead making this a two-cycle instruction. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1(2)
Note: 3 cycles if skip and followed by a 2-word instruction

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	No operation

If skip:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

If skip and followed by 2-word instruction:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation
No operation	No operation	No operation	No operation

Example:
```
HERE    CPFSEQ REG, 0
NEQUAL  :
EQUAL   :
```

Before Instruction
PC Address = HERE
W = ?
REG = ?
After Instruction
If REG = W;
PC = Address (EQUAL)
If REG ≠ W;
PC = Address (NEQUAL)

CPFSGT — Compare f with W, skip if f > W

Syntax: [*label*] CPFSGT f,a

Operands: $0 \le f \le 255$
$a \in [0,1]$

Operation: (f) – (W),
skip if (f) > (W)
(unsigned comparison)

Status Affected: None

Encoding:

0110	010a	ffff	ffff

Description: Compares the contents of data memory location 'f' to the contents of the W by performing an unsigned subtraction.

If the contents of 'f' are greater than the contents of W then the fetched instruction is discarded and an NOP is executed instead making this a two-cycle instruction. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1(2)
Note: 3 cycles if skip and followed by a 2-word instruction

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	No operation

If skip:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

If skip and followed by 2-word instruction:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation
No operation	No operation	No operation	No operation

Example:
```
HERE      CPFSGT REG, 0
NGREATER  :
GREATER   :
```

Before Instruction
PC = Address (HERE)
W = ?

After Instruction
If REG > W;
PC = Address (GREATER)
If REG ≤ W;
PC = Address (NGREATER)

CPFSLT — Compare f with W, skip if f < W

Syntax: [*label*] CPFSLT f,a

Operands: $0 \le f \le 255$
$a \in [0,1]$

Operation: (f) – (W),
skip if (f) < (W)
(unsigned comparison)

Status Affected: None

Encoding:

0110	000a	ffff	ffff

Description: Compares the contents of data memory location 'f' to the contents of W by performing an unsigned subtraction.

If the contents of 'f' are less than the contents of W, then the fetched instruction is discarded and an NOP is executed instead making this a two-cycle instruction. If 'a' is 0 Virtual bank will be selected. If 'a' is 1 the BSR will not be overridden (default).

Words: 1

Cycles: 1(2)
Note: 3 cycles if skip and followed by a 2-word instruction

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	No operation

If skip:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

If skip and followed by 2-word instruction:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation
No operation	No operation	No operation	No operation

Example:
```
HERE    CPFSLT REG, 1
NLESS   :
LESS    :
```

Before Instruction
PC = Address (HERE)
W = ?

After Instruction
If REG < W;
PC = Address (LESS)
If REG ≥ W;
PC = Address (NLESS)

DAW — Decimal Adjust W Register

Syntax: [*label*] DAW

Operands: None

Operation:
If [W<3:0> >9] or [DC = 1] then
(W<3:0>) + 6 → W<3:0>;
else
(W<3:0>) → W<3:0>;

If [W<7:4> >9] or [C = 1] then
(W<7:4>) + 6 → W<7:4>;
else
(W<7:4>) → W<7:4>;

Status Affected: C

Encoding:

0000	0000	0000	0111

Description: DAW adjusts the eight bit value in W resulting from the earlier addition of two variables (each in packed BCD format) and produces a correct packed BCD result.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register W	Process Data	Write W

Example1: DAW

Before Instruction
W = 0xA5
C = 0
DC = 0

After Instruction
W = 0x05
C = 1
DC = 0

Example 2:

Before Instruction
W = 0xCE
C = 0
DC = 0

After Instruction
W = 0x34
C = 1
DC = 0

DECF — Decrement f

Syntax: [*label*] DECF f,d,a

Operands: 0 ≤ f ≤ 255
d ∈ [0,1]
a ∈ [0,1]

Operation: (f) – 1 → dest

Status Affected: C,DC,N,OV,Z

Encoding:

0000	01da	ffff	ffff

Description: Decrement register 'f'. If 'd' is 0 the result is stored in W. If 'd' is 1 the result is stored back in register 'f' (default). If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example: DECF CNT, 1, 0

Before Instruction
CNT = 0x01
Z = 0

After Instruction
CNT = 0x00
Z = 1

DECFSZ **Decrement f, skip if 0**

Syntax: [*label*] DECFSZ f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: (f) – 1 → dest,
skip if result = 0

Status Affected: None

Encoding:

0010	11da	ffff	ffff

Description: The contents of register 'f' are decremented. If 'd' is 0 the result is placed in W. If 'd' is 1 the result is placed back in register 'f' (default).
If the result is 0, the next instruction, which is already fetched, is discarded, and an NOP is executed instead making it a two-cycle instruction. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1(2)
Note: 3 cycles if skip and followed by a 2-word instruction

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

If skip:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

If skip and followed by 2-word instruction:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation
No operation	No operation	No operation	No operation

Example:
```
HERE    DECFSZ  CNT, 1, 1
        GOTO    LOOP
CONTINUE
```

Before Instruction
PC = Address (HERE)
After Instruction
CNT = CNT - 1
If CNT = 0;
PC = Address (CONTINUE)
If CNT ≠ 0;
PC = Address (HERE+2)

DCFSNZ **Decrement f, skip if not 0**

Syntax: [*label*] DCFSNZ f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: (f) – 1 → dest,
skip if result ≠ 0

Status Affected: None

Encoding:

0100	11da	ffff	ffff

Description: The contents of register 'f' are decremented. If 'd' is 0 the result is placed in W. If 'd' is 1 the result is placed back in register 'f' (default).
If the result is not 0, the next instruction, which is already fetched, is discarded, and an NOP is executed instead making it a two-cycle instruction. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value(default).

Words: 1

Cycles: 1(2)
Note: 3 cycles if skip and followed by a 2-word instruction

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

If skip:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

If skip and followed by 2-word instruction:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation
No operation	No operation	No operation	No operation

Example:
```
HERE    DCFSNZ  TEMP, 1, 0
ZERO    :
NZERO   :
```

Before Instruction
TEMP = ?
After Instruction
TEMP = TEMP - 1,
If TEMP = 0;
PC = Address (ZERO)
If TEMP ≠ 0;
PC = Address (NZERO)

GOTO — Unconditional Branch

Syntax: [*label*] GOTO k

Operands: $0 \le k \le 1048575$

Operation: k → PC<20:1>

Status Affected: None

Encoding:

1st word (k<7:0>)	1110	1111	k_7kkk	$kkkk_0$
2nd word(k<19:8>)	1111	$k_{19}kkk$	kkkk	$kkkk_8$

Description: GOTO allows an unconditional branch anywhere within entire 2M byte memory range. The 20-bit value 'k' is loaded into PC<20:1>. GOTO is always a two-cycle instruction.

Words: 2

Cycles: 2

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'<7:0>,	No operation	Read literal 'k'<19:8>, Write to PC
No operation	No operation	No operation	No operation

Example: GOTO THERE

After Instruction

PC = Address (THERE)

HALT — Halt Processor

Syntax: [*label*] HALT

Operands: None

Operation: Processor halts execution after HALT instruction

Status Affected: None

Encoding:

0000	0000	0000	0001

Description: While functioning in emulation mode, execution of the halt instruction will halt processor execution. Toggling the HALT pin or resetting ($\overline{MCLR}$ = 0) will bring the device out of halt. HALT instruction is not recognized in non-emulation modes.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	No operation	HALT

INCF — Increment f

Syntax: [*label*] INCF f,d,a

Operands: 0 ≤ f ≤ 255
d ∈ [0,1]
a ∈ [0,1]

Operation: (f) + 1 → dest

Status Affected: C,DC,N,OV,Z

Encoding:

0010	10da	ffff	ffff

Description: The contents of register 'f' are incremented. If 'd' is 0 the result is placed in W. If 'd' is 1 the result is placed back in register 'f' (default). If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example:

```
INCF    CNT, 1, 0
```

Before Instruction
CNT = 0xFF
Z = 0
C = ?
DC = ?

After Instruction
CNT = 0x00
Z = 1
C = 1
DC = 1

INCFSZ — Increment f, skip if 0

Syntax: [*label*] INCFSZ f,d,a

Operands: 0 ≤ f ≤ 255
d ∈ [0,1]
a ∈ [0,1]

Operation: (f) + 1 → dest,
skip if result = 0

Status Affected: None

Encoding:

0011	11da	ffff	ffff

Description: The contents of register 'f' are incremented. If 'd' is 0 the result is placed in W. If 'd' is 1 the result is placed back in register 'f'. (default)
If the result is 0, the next instruction, which is already fetched, is discarded, and an NOP is executed instead making it a two-cycle instruction. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1(2)
Note: 3 cycles if skip and followed by a 2-word instruction

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

If skip:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

If skip and followed by 2-word instruction:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation
No operation	No operation	No operation	No operation

Example:

```
HERE    INCFSZ  CNT, 1, 0
NZERO   :
ZERO    :
```

Before Instruction
PC = Address (HERE)

After Instruction
CNT = CNT + 1
If CNT = 0;
PC = Address (ZERO)
If CNT ≠ 0;
PC = Address (NZERO)

INFSNZ **Increment f, skip if not 0**

Syntax: [*label*] INFSNZ f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: (f) + 1 → dest,
skip if result ≠ 0

Status Affected: None

Encoding:

0100	10da	ffff	ffff

Description: The contents of register 'f' are incremented. If 'd' is 0 the result is placed in W. If 'd' is 1 the result is placed back in register 'f' (default).
If the result is not 0, the next instruction, which is already fetched, is discarded, and an NOP is executed instead making it a two-cycle instruction. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1(2)
Note: 3 cycles if skip and followed by a 2-word instruction

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

If skip:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

If skip and followed by 2-word instruction:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation
No operation	No operation	No operation	No operation

Example:
```
HERE    INFSNZ  REG, 1, 0
ZERO
NZERO
```

Before Instruction
PC = Address (HERE)

After Instruction
REG = REG + 1
If REG ≠ 0;
PC = Address (NZERO)
If REG = 0;
PC = Address (ZERO)

IORLW **Inclusive OR literal with W**

Syntax: [*label*] IORLW k

Operands: $0 \le k \le 255$

Operation: (W) .OR. k → W

Status Affected: N,Z

Encoding:

0000	1001	kkkk	kkkk

Description: The contents of W are OR'ed with the eight bit literal 'k'. The result is placed in W.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process Data	Write to W

Example:
```
IORLW   0x35
```

Before Instruction
W = 0x9A

After Instruction
W = 0xBF

IORWF — Inclusive OR W with f

Syntax: [*label*] IORWF f,d,a

Operands: 0 ≤ f ≤ 255
d ∈ [0,1]
a ∈ [0,1]

Operation: (W) .OR. (f) → dest

Status Affected: N,Z

Encoding:

0001	00da	ffff	ffff

Description: Inclusive OR W with register 'f'. If 'd' is 0 the result is placed in W. If 'd' is 1 the result is placed back in register 'f' (default). If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example: `IORWF RESULT, 0, 1`

Before Instruction
RESULT = 0x13
W = 0x91

After Instruction
RESULT = 0x13
W = 0x93

MOVF — Move f

Syntax: [*label*] MOVF f,d,a

Operands: 0 ≤ f ≤ 255
d ∈ [0,1]
a ∈ [0,1]

Operation: f → dest

Status Affected: N,Z

Encoding:

0101	00da	ffff	ffff

Description: The contents of register 'f' is moved to a destination dependent upon the status of 'd'. If 'd' is 0 the result is placed in W. If 'd' is 1 the result is placed back in register 'f' (default). Location 'f' can be anywhere in the 256 byte bank. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write W

Example: `MOVF REG, 0, 0`

Before Instruction
REG = 0x22
W = 0xFF

After Instruction
REG = 0x22
W = 0x22

MOVFF **Move f to f**

Syntax: [*label*] MOVFF f_s,f_d

Operands: $0 \le f_s \le 4095$
$0 \le f_d \le 4095$

Operation: $(f_s) \rightarrow f_d$

Status Affected: None

Encoding:

1st word (source)	1100	ffff	ffff$_s$
2nd word (destin.)	1111	ffff	ffff$_d$

Description: The contents of source register 'f_s' are moved to destination register 'f_d'. Location of source 'f_s' can be anywhere in the 4096 byte data space (000h to FFFh), and location of destination 'f_d' can also be anywhere from 000h to FFFh.

Either source or destination can be W (a useful special situation).

MOVFF is particularly useful for transferring a data memory location to a peripheral register (such as the transmit buffer or an I/O port).

The MOVFF instruction cannot use the PCL, TOSU, TOSH or TOSL as the destination register

Words: 2

Cycles: 2 (3)

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f' (src)	Process Data	No operation
Decode	No operation No dummy read	No operation	Write register 'f' (dest)

Example: MOVFF REG1, REG2

Before Instruction
REG1 = 0x33
REG2 = 0x11

After Instruction
REG1 = 0x33,
REG2 = 0x33

MOVLB **Move literal to low nibble in BSR**

Syntax: [*label*] MOVLB k

Operands: $0 \le k \le 255$

Operation: k → BSR

Status Affected: None

Encoding:

0000	0001	kkkk	kkkk

Description: The 8-bit literal 'k' is loaded into the Bank Select Register (BSR).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process Data	Write literal 'k' to BSR

Example: MOVLB 5

Before Instruction
BSR register = 0x02

After Instruction
BSR register = 0x05

LFSR **Move literal to FSR**

Syntax: [*label*] LFSR f,k

Operands: $0 \le f \le 2$
$0 \le k \le 4095$

Operation: $k \rightarrow FSRf$

Status Affected: None

Encoding:

1110 1111	1110 0000	00ff $k_7$kkk	k_{11}kkk kkkk

Description: The 12-bit literal 'k' is loaded into the file select register pointed to by 'f'

Words: 2

Cycles: 2

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k' MSB	Process Data	Write literal 'k' MSB to FSRfH
Decode	Read literal 'k' LSB	Process Data	Write literal 'k' to FSRfL

Example: `LFSR 2, 0x3AB`

After Instruction
FSR2H = 0x03
FSR2L = 0xAB

MOVLW **Move literal to W**

Syntax: [*label*] MOVLW k

Operands: $0 \le k \le 255$

Operation: $k \rightarrow W$

Status Affected: None

Encoding:

0000	1110	kkkk	kkkk

Description: The eight bit literal 'k' is loaded into W.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process Data	Write to W

Example: `MOVLW 0x5A`

After Instruction
W = 0x5A

MOVWF Move W to f

Syntax: [*label*] MOVWF f,a

Operands: $0 \le f \le 255$
$a \in [0,1]$

Operation: (W) → f

Status Affected: None

Encoding:

0110	111a	ffff	ffff

Description: Move data from W to register 'f'. Location 'f' can be anywhere in the 256 byte bank. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write register 'f'

Example: `MOVWF REG, 0`

Before Instruction
W = 0x4F
REG = 0xFF

After Instruction
W = 0x4F
REG = 0x4F

MULLW Multiply Literal with W

Syntax: [*label*] MULLW k

Operands: $0 \le k \le 255$

Operation: (W) x k → PRODH:PRODL

Status Affected: None

Encoding:

0000	1101	kkkk	kkkk

Description: An unsigned multiplication is carried out between the contents of W and the 8-bit literal 'k'. The 16-bit result is placed in PRODH:PRODL register pair. PRODH contains the high byte.
W is unchanged.
None of the status flags are affected.
Note that neither overflow nor carry is possible in this operation. A zero result is possible but not detected.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process Data	Write registers PRODH: PRODL

Example: `MULLW 0xC4`

Before Instruction
W = 0xE2
PRODH = ?
PRODL = ?

After Instruction
W = 0xE2
PRODH = 0xAD
PRODL = 0x08

MULWF — Multiply W with f

Syntax: [*label*] MULWF f,a

Operands: $0 \le f \le 255$
$a \in [0,1]$

Operation: (W) x (f) → PRODH:PRODL

Status Affected: None

Encoding:

0000	001a	ffff	ffff

Description: An unsigned multiplication is carried out between the contents of W and the register file location 'f'. The 16-bit result is stored in the PRODH:PRODL register pair. PRODH contains the high byte.
Both W and 'f' are unchanged.
None of the status flags are affected.
Note that neither overflow nor carry is possible in this operation. A zero result is possible but not detected. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write registers PRODH: PRODL

Example:
```
MULWF   REG, 1
```
Before Instruction
W = 0xC4
REG = 0xB5
PRODH = ?
PRODL = ?
After Instruction
W = 0xC4
REG = 0xB5
PRODH = 0x8A
PRODL = 0x94

NEGF — Negate f

Syntax: [*label*] NEGF f,a

Operands: $0 \le f \le 255$
$a \in [0,1]$

Operation: $(\bar{f}) + 1 \rightarrow f$

Status Affected: N,OV, C, DC, Z

Encoding:

0110	110a	ffff	ffff

Description: Location 'f' is negated using two's complement. The result is placed in the data memory location 'f'. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write register 'f'

Example:
```
NEGF    REG, 1
```
Before Instruction
REG = 0011 1010 [0x3A]
After Instruction
REG = 1100 0110 [0xC6]

NOP — No Operation

Syntax: [*label*] NOP

Operands: None

Operation: No operation

Status Affected: None

Encoding:

0000 1111	0000 xxxx	0000 xxxx	0000 xxxx

Description: No operation.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	No operation	No operation

Example:

None.

POP — Pop Top of Return Stack

Syntax: [*label*] POP

Operands: None

Operation: (TOS) → bit bucket

Status Affected: None

Encoding:

0000	0000	0000	0110

Description: The TOS value is pulled off the return stack and is discarded. The TOS value then becomes the previous value that was pushed onto the return stack.

This instruction is provided to enable the user to properly manage the return stack to incorporate a software stack.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	POP TOS value	No operation

Example:

```
POP
GOTO    NEW
```

Before Instruction
TOS = 0031A2h
Stack (1 level down) = 014332h

After Instruction
TOS = 014332h
PC = NEW

PUSH — Push Top of Return Stack

Syntax: [*label*] PUSH

Operands: None

Operation: (PC+2) → TOS

Status Affected: None

Encoding:

0000	0000	0000	0101

Description: The PC+2 is pushed onto the top of the return stack. The previous TOS value is pushed down on the stack.

This instruction allows to implement a software stack by modifying TOS, and then push it onto the return stack.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	PUSH PC+2 onto return stack	No operation	No operation

Example:

```
PUSH
```

Before Instruction
- TOS = 00345Ah
- PC = 000124h

After Instruction
- PC = 000126h
- TOS = 000126h
- Stack (1 level down) = 00345Ah

RCALL — Branch Subroutine

Syntax: [*label*] RCALL n

Operands: -1024 ≤ n ≤ 1023

Operation: (PC) + 2 → TOS,
(PC) + 2 + 2n → PC

Status Affected: None

Encoding:

1101	1nnn	nnnn	nnnn

Description: Subroutine call with a jump upto 1K from the current location. First, return address (PC+2) is pushed onto the stack. Then, add the 2's complement number '2n' to the PC. Since the PC will have incremented to fetch the next instruction, the new address will be PC+2+2n. This instruction is a two-cycle instruction.

Words: 1

Cycles: 2

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'n' Push PC to stack	Process Data	Write to PC
No operation	No operation	No operation	No operation

Example:

```
HERE    RCALL Jump
```

Before Instruction
- PC = Address (HERE)

After Instruction
- PC = Address (Jump)
- TOS = Address (HERE+2)

RESET **Reset**

Syntax: [*label*] RESET

Operands: None

Operation: Reset all registers and flags that are affected by a $\overline{\text{MCLR}}$ reset.

Status Affected: All

Encoding:

0000	0000	1111	1111

Description: This instruction provides a way to execute a $\overline{\text{MCLR}}$ reset in software.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Start reset	No operation	No operation

Example: RESET

After Instruction
Registers = Reset Value
Flags* = Reset Value

RETFIE **Return from Interrupt**

Syntax: [*label*] RETFIE s

Operands: s ∈ [0,1]

Operation: (TOS) → PC,
1 → GIE/GIEH or PEIE/GIEL,
if s = 1
(WS) → W,
(STATUSS) → STATUS,
(BSRS) → BSR,
PCLATU, PCLATH are unchanged.

Status Affected: GIE/GIEH,PEIE/GIEL,STATUS reg.

Encoding:

0000	0000	0001	000s

Description: Return from Interrupt. Stack is popped and Top of Stack (TOS) is loaded into the PC. Interrupts are enabled by setting the either the high or low priority global interrupt enable bit. If 's' = 1, the contents of the shadow registers WS, STATUSS and BSRS are loaded into their corresponding registers, W, STATUS and BSR. If 's' = 0, no update of these registers occurs (default).

Words: 1

Cycles: 2

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	No operation	pop PC from stack Set GIEH or GIEL
No operation	No operation	No operation	No operation

Example: RETFIE Fast

After Interrupt
PC = TOS
W = WS
BSR = BSRS
STATUS = STATUSS
GIE/GIEH, PEIE/GIEL = 1

RLCF — Rotate Left f through Carry

Syntax: [*label*] RLCF f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: (f<n>) → dest<n+1>,
(f<7>) → C,
(C) → dest<0>

Status Affected: C,N,Z

Encoding:

0011	01da	ffff	ffff

Description: The contents of register 'f' are rotated one bit to the left through the Carry Flag. If 'd' is 0 the result is placed in W. If 'd' is 1 the result is stored back in register 'f' (default). If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' = 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example: RLCF REG, 0, 0

Before Instruction
REG = 1110 0110
C = 0

After Instruction
REG = 1110 0110
W = 1100 1100
C = 1

RLNCF — Rotate Left f (no carry)

Syntax: [*label*] RLNCF f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

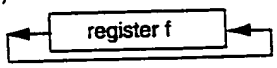
Operation: (f<n>) → dest<n+1>,
(f<7>) → dest<0>

Status Affected: N,Z

Encoding:

0100	01da	ffff	ffff

Description: The contents of register 'f' are rotated one bit to the left. If 'd' is 0 the result is placed in W. If 'd' is 1 the result is stored back in register 'f' (default). If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' is 1, then the bank will be selected as per the BSR value (default).



Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example: RLNCF REG, 1, 0

Before Instruction
REG = 1010 1011

After Instruction
REG = 0101 0111

RRCF — Rotate Right f through Carry

Syntax: [*label*] RRCF f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

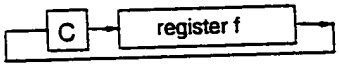
Operation: (f<n>) → dest<n-1>,
(f<0>) → C,
(C) → dest<7>

Status Affected: C,N,Z

Encoding:

0011	00da	ffff	ffff

Description: The contents of register 'f' are rotated one bit to the right through the Carry Flag. If 'd' is 0 the result is placed in W. If 'd' is 1 the result is placed back in register 'f' (default). If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' is 1, then the bank will be selected as per the BSR value (default).



Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example: RRCF REG, 0, 0

Before Instruction
REG = 1110 0110
C = 0

After Instruction
REG = 1110 0110
W = 0111 0011
C = 0

RRNCF — Rotate Right f (no carry)

Syntax: [*label*] RRNCF f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: (f<n>) → dest<n-1>,
(f<0>) → dest<7>

Status Affected: N,Z

Encoding:

0100	00da	ffff	ffff

Description: The contents of register 'f' are rotated one bit to the right. If 'd' is 0 the result is placed in W. If 'd' is 1 the result is placed back in register 'f' (default). If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' is 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example 1: RRNCF REG, 1, 0

Before Instruction
REG = 1101 0111

After Instruction
REG = 1110 1011

Example 2: RRNCF REG, 0, 0

Before Instruction
W = ?
REG = 1101 0111

After Instruction
W = 1110 1011
REG = 1101 0111

SETF — Set f

Syntax: [*label*] SETF f,a

Operands: $0 \le f \le 255$
$a \in [0,1]$

Operation: FFh → f

Status Affected: None

Encoding:

0110	100a	ffff	ffff

Description: The contents of the specified register are set to FFh. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' is 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write register 'f'

Example: `SETF REG,1`

Before Instruction
REG = 0x5A
After Instruction
REG = 0xFF

SLEEP — Enter SLEEP mode

Syntax: [*label*] SLEEP

Operands: None

Operation: 00h → WDT,
0 → WDT postscaler,
1 → $\overline{TO}$,
0 → $\overline{PD}$

Status Affected: $\overline{TO}$, $\overline{PD}$

Encoding:

0000	0000	0000	0011

Description: The power-down status bit ($\overline{PD}$) is cleared. The time-out status bit ($\overline{TO}$) is set. Watchdog Timer and its postscaler are cleared.
The processor is put into SLEEP mode with the oscillator stopped.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	Process Data	Go to sleep

Example: `SLEEP`

Before Instruction
$\overline{TO}$ = ?
$\overline{PD}$ = ?
After Instruction
$\overline{TO}$ = 1 †
$\overline{PD}$ = 0

† If WDT causes wake-up, this bit is cleared

SUBFWB **Subtract f from W with borrow**

Syntax: [*label*] SUBFWB f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: (W) – (f) – ($\overline{C}$) → dest

Status Affected: N,OV, C, DC, Z

Encoding:

0101	01da	ffff	ffff

Description: Subtract register 'f' and carry flag (borrow) from W (2's complement method). If 'd' is 0 the result is stored in W. If 'd' is 1 the result is stored in register 'f' (default) . If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' is 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

SUBFWB

Example 1: `SUBFWB REG, 1, 0`

Before Instruction
REG = 3
W = 2
C = 1

After Instruction
REG = FF
W = 2
C = 0
Z = 0
N = 1 ; result is negative

Example 2: `SUBFWB REG, 0, 0`

Before Instruction
REG = 2
W = 5
C = 1

After Instruction
REG = 2
W = 3
C = 1
Z = 0
N = 0 ; result is positive

Example 3: `SUBFWB REG, 1, 0`

Before Instruction
REG = 1
W = 2
C = 0

After Instruction
REG = 0
W = 2
C = 1
Z = 1 ; result is zero
N = 0

SUBLW — Subtract W from literal

Syntax: [*label*] SUBLW k

Operands: $0 \le k \le 255$

Operation: $k - (W) \rightarrow W$

Status Affected: N,OV, C, DC, Z

Encoding:

0000	1000	kkkk	kkkk

Description: W is subtracted from the eight bit literal 'k'. The result is placed in W.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process Data	Write to W

Example 1:

```
SUBLW   0x02
```

Before Instruction

```
W   =   1
C   =   ?
```

After Instruction

```
W   =   1
C   =   1   ; result is positive
Z   =   0
N   =   0
```

Example 2:

```
SUBLW   0x02
```

Before Instruction

```
W   =   2
C   =   ?
```

After Instruction

```
W   =   0
C   =   1   ; result is zero
Z   =   1
N   =   0
```

Example 3:

```
SUBLW   0x02
```

Before Instruction

```
W   =   3
C   =   ?
```

After Instruction

```
W   =   FF  ; (2's complement)
C   =   0   ; result is negative
Z   =   0
N   =   1
```

SUBWF — Subtract W from f

Syntax: [*label*] SUBWF f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: $(f) - (W) \rightarrow dest$

Status Affected: N,OV, C, DC, Z

Encoding:

0101	11da	ffff	ffff

Description: Subtract W from register 'f' (2's complement method). If 'd' is 0 the result is stored in W. If 'd' is 1 the result is stored back in register 'f' (default). If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' is 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example 1: `SUBWF REG, 1, 0`

Before Instruction
REG = 3
W = 2
C = ?

After Instruction
REG = 1
W = 2
C = 1 ; result is positive
Z = 0
N = 0

Example 2: `SUBWF REG, 0, 0`

Before Instruction
REG = 2
W = 2
C = ?

After Instruction
REG = 2
W = 0
C = 1 ; result is zero
Z = 1
N = 0

Example 3: `SUBWF REG, 1, 0`

Before Instruction
REG = 1
W = 2
C = ?

After Instruction
REG = FFh ;(2's complement)
W = 2
C = 0 ; result is negative
Z = 0
N = 1

SUBWFB Subtract W from f with Borrow

Syntax: [*label*] SUBWFB f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: (f) – (W) – ($\overline{C}$) → dest

Status Affected: N,OV, C, DC, Z

Encoding:

0101	10da	ffff	ffff

Description: Subtract W and the carry flag (borrow) from register 'f' (2's complement method). If 'd' is 0 the result is stored in W. If 'd' is 1 the result is stored back in register 'f' (default). If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' is 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

SUBWFB

Example 1: `SUBWFB REG, 1, 0`

Before Instruction
REG = 0x19 (0001 1001)
W = 0x0D (0000 1101)
C = 1

After Instruction
REG = 0x0C (0000 1011)
W = 0x0D (0000 1101)
C = 1
Z = 0
N = 0 ; result is positive

Example2: `SUBWFB REG, 0, 0`

Before Instruction
REG = 0x1B (0001 1011)
W = 0x1A (0001 1010)
C = 0

After Instruction
REG = 0x1B (0001 1011)
W = 0x00
C = 1
Z = 1 ; result is zero
N = 0

Example3: `SUBWFB REG, 1, 0`

Before Instruction
REG = 0x03 (0000 0011)
W = 0x0E (0000 1101)
C = 1

After Instruction
REG = 0xF5 (1111 0100) [2's comp]
W = 0x0E (0000 1101)
C = 0
Z = 0
N = 1 ; result is negative

SWAPF **Swap f**

Syntax: [*label*] SWAPF f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: (f<3:0>) → dest<7:4>,
(f<7:4>) → dest<3:0>

Status Affected: None

Encoding:

0011	10da	ffff	ffff

Description: The upper and lower nibbles of register 'f' are exchanged. If 'd' is 0 the result is placed in W. If 'd' is 1 the result is placed in register 'f' (default). If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' is 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example:
```
SWAPF   REG, 1, 0
```
Before Instruction
REG = 0x53
After Instruction
REG = 0x35

TBLRD **Table Read**

Syntax: [*label*] TBLRD (*; *+; *-; +*)

Operands: None

Operation:
if TBLRD *,
(Prog Mem (TBLPTR)) → TABLAT;
TBLPTR - No Change;
if TBLRD *+,
(Prog Mem (TBLPTR)) → TABLAT;
(TBLPTR) +1 → TBLPTR;
if TBLRD *-,
(Prog Mem (TBLPTR)) → TABLAT;
(TBLPTR) -1 → TBLPTR;
if TBLRD +*,
(TBLPTR) +1 → TBLPTR;
(Prog Mem (TBLPTR)) → TABLAT;

Status Affected: None

Encoding:

0000	0000	0000	10nn nn=0 * =1 *+ =2 *- =3 +*

Description: There are four options with a TBLRD instruction to determine what happens to the 21-bit Table Pointer (TBLPTR): no change, post-increment, post-decrement and pre-increment. The current option is determined and the TBLPTR is modified appropriately, and the contents of the program memory location pointed to by the TBLPTR are loaded into the 8-bit Table Latch (TABLAT). The LSb of the TBLPTR selects which byte of the program memory location will be read. If LSb = 1, the high byte will be loaded into the TABLAT. If LSb = 0, the low byte will be loaded into the TABLAT.

Words: 1

Cycles: 2

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	No operation	No operation
No operation	No operation (Table Pointer on Address bus)	No operation	No operation ($\overline{OE}$ goes low) TABLAT updated

TBLRD **Table Read**

Example1: `TBLRD *+ ;`

Before Instruction
TABLAT = 0x55
TBLPTR = 0x00A356
MEMORY(0x00A356) = 0x34
After Instruction
TABLAT = 0x34
TBLPTR = 0x00A357

Example2: `TBLRD +* ;`

Before Instruction
TABLAT = 0xAA
TBLPTR = 0x01A357
MEMORY(0x01A357) = 0x12
MEMORY(0x01A358) = 0x34
After Instruction
TABLAT = 0x34
TBLPTR = 0x01A358

TBLWT **Table Write**

Syntax: [*label*] TBLWT (*; *+; *-; +*)

Operands: None

Operation:
if TBLWT *,
(TABLAT) → Prog Mem(TBLPTR);
TBLPTR - No Change;
if TBLWT *+,
(TABLAT) → Prog Mem(TBLPTR);
(TBLPTR) +1 → TBLPTR;
if TBLWT *-,
(TABLAT) → Prog Mem(TBLPTR);
(TBLPTR) -1 → TBLPTR;
if TBLWT +*,
(TBLPTR) +1 → TBLPTR;
(TABLAT) → Prog Mem(TBLPTR);

Status Affected: None

Encoding:

0000	0000	0000	11nn nn=0 * =1 *+ =2 *- =3 +*

Description:

There are four options with a TBLWT instruction. These options determine what happens to the Table Pointer (TBLPTR): no change, post-increment, post-decrement and pre-increment. The current option is determined and the TBLPTR is modified appropriately.

The contents of Table Latch (TABLAT) are written to the program memory location pointed to by TBLPTR.

If TBLPTR points to an external program memory location, then the instruction executes in two cycles.

Since the TABLAT is only one byte wide, a multiple of two TBLWT instructions must be executed to program internal memory locations. For example, if the device is defined to program one word at time, an internal memory location is programed in the following manner:

1) Set TBLPTR to an even byte
2) Write low byte to TABLAT
3) Execute TBLWT *+ (2-cycle)
4) Write high byte to TABLAT
5) Execute TBLWT *+ (long write)

A long write to an internal EPROM location is terminated when an interrupt is received. The post increment TBLWT instruction is the only TBLWT instruction that is recommended for writes to internal memory. (Writes to internal EPROM are only available on devices with 64 or more pins.)

Words: 1

TBLWT **Table Write**

Cycles: 2 (many if long write is to on-chip EPROM program memory)

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	No operation	No operation
No operation	No operation (Table Pointer on Address bus)	No operation	No operation (Table Latch on Address bus, $\overline{WR}$ goes low)

Example1: `TBLWT *+;`

Before Instruction
TABLAT = 0x55
TBLPTR = 0x00A356
MEMORY(0x00A356) = 0xFF

After Instructions (table write completion)
TABLAT = 0x55
TBLPTR = 0x00A357
MEMORY(0x00A356) = 0x55

Example 2: `TBLWT +*;`

Before Instruction
TABLAT = 0x34
TBLPTR = 0x01389A
MEMORY(0x01389A) = 0xFF
MEMORY(0x01389B) = 0xFF

After Instruction (table write completion)
TABLAT = 0x34
TBLPTR = 0x01389B
MEMORY(0x01389A) = 0xFF
MEMORY(0x01389B) = 0x34

TRAP — Debugger Subroutine Call

Syntax: [*label*] TRAP

Operands: None

Operation: (PC) + 2 → TOS,
000028h → PC<20:1>

Status Affected: INBUG

Encoding:

0000	0000	1110	0000

Description: Debugger Trap to 00028h. First, return address (PC+ 2) is pushed onto the return stack. Then the 20-bit value '000028h' is loaded into PC<20:1>. The INBUG status bit is set. TRAP is a two-cycle instruction.

Words: 1

Cycles: 2

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Push PC to stack	No operation	Write 000028h to PC
No operation	No operation	No operation	No operation

Example: HERE TRAP

Before Instruction
PC = Address(HERE)

After Instruction
PC = 000028h
TOS = Address (HERE + 2)
INBUG = 1

TRET — Trap Return from Subroutine

Syntax: [*label*] TRET

Operands: None

Operation: (TOS) → PC
PCLATU, PCLATH are unchanged

Status Affected: INBUG

Encoding:

0000	0000	1110	0001

Description: Return from debugger trap. The stack is popped and the top of the stack (TOS) is loaded into the program counter. The INBUG status bit is cleared.

Words: 1

Cycles: 2

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	No operation	No operation	pop PC from stack
No operation	No operation	No operation	No operation

Example: TRET

After Interrupt
PC = TOS
INBUG = 0

TSTFSZ — Test f, skip if 0

Syntax: [*label*] TSTFSZ f,a

Operands: $0 \le f \le 255$
$a \in [0,1]$

Operation: skip if f = 0

Status Affected: None

Encoding:

0110	011a	ffff	ffff

Description: If 'f' = 0, the next instruction, fetched during the current instruction execution, is discarded and a NOP is executed making this a two-cycle instruction. If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' is 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1(2)
Note: 3 cycles if skip and followed by a 2-word instruction

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	No operation

If skip:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation

If skip and followed by 2-word instruction:

Q1	Q2	Q3	Q4
No operation	No operation	No operation	No operation
No operation	No operation	No operation	No operation

Example:
```
HERE    TSTFSZ  CNT, 1
NZERO     :
ZERO      :
```

Before Instruction
PC = Address(HERE)

After Instruction
If CNT = 0x00,
PC = Address (ZERO)
If CNT ≠ 0x00,
PC = Address (NZERO)

XORLW — Exclusive OR literal with W

Syntax: [*label*] XORLW k

Operands: $0 \le k \le 255$

Operation: (W) .XOR. k → W

Status Affected: N,Z

Encoding:

0000	1010	kkkk	kkkk

Description: The contents of W are XOR'ed with the 8-bit literal 'k'. The result is placed in W.

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read literal 'k'	Process Data	Write to W

Example:
```
XORLW  0xAF
```

Before Instruction
W = 0xB5

After Instruction
W = 0x1A

XORWF — Exclusive OR W with f

Syntax: [*label*] XORWF f,d,a

Operands: $0 \le f \le 255$
$d \in [0,1]$
$a \in [0,1]$

Operation: (W) .XOR. (f) → dest

Status Affected: N,Z

Encoding:

0001	10da	ffff	ffff

Description: Exclusive OR the contents of W with register 'f'. If 'd' is 0 the result is stored in W. If 'd' is 1 the result is stored back in the register 'f' (default). If 'a' is 0 Virtual bank will be selected, overriding the BSR value. If 'a' is 1, then the bank will be selected as per the BSR value (default).

Words: 1

Cycles: 1

Q Cycle Activity:

Q1	Q2	Q3	Q4
Decode	Read register 'f'	Process Data	Write to destination

Example:

```
XORWF   REG, 1, 0
```

Before Instruction
REG = 0xAF
W = 0xB5

After Instruction
REG = 0x1A
W = 0xB5